Space Weather Technical Forecast

Issued on Tuesday, 25 January 2022 at 13:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance G1 Minor Geomagnetic Storm, mainly day 1 and 4 (25th and 28th). Active fluence likely easing.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low in the past 24 hours with two C-flares, peaking C3.7 at 25/1029 UTC from a region over the northeast limb. There are four regions on the visible-side. AR2935 Cro/Beta in the north centre disc, was the source of a B8-flare and associated filament lift with CME around 25/0220 UTC, but has shown little development since. AR2936 Dso/Beta near the northeast limb is set within a region of plage and has shown some limited development, but has been largely inactive. AR2934 Hsx/alpha has also remained inactive in the southeastern quadrant. A further unnumbered region developed to the northeast of AR2934, and whilst the most developmental area remains a simple Bxo/Beta. The CME which lifted from near AR2935 has been assessed as likely passing over the Earth, but with a chance of a glancing arrival around 29/0000UTC +/- 9 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, was initially of a slow regime, with speeds around 300 km/s, but have been increasing since 25/0400 UTC to peak 380km/s. The density of the wind has been mainly above average, over 20 ppcc, with a peak of 65 ppcc at 25/0407 UTC, but also with a period of closer to average density 10-20ppcc 24/1900UTC-25/0200UTC. Total Interplanetary Magnetic Field (IMF) strength, Bt, increased to moderate levels peaking 10nT around 24/2000 UTC, eased again by 25/0400 UTC, before becoming moderate again and peaking 13nT around 25/1000 UTC. Likewise the north-south component Bz, become persistently negative, peaking -5nT between 24/1900-0400 UTC, before becoming highly variable between -8nT and +10nT. The phi angle remained generally negative (towards the Sun) until 24/0430UTC, when it switched to be more variable by generally positive (Away from Sun). These measures suggest the glancing influence of a CME 24/1900-25/0400 followed by the CIR region ahead of CH46 0400 onward. Despite this geomagnetic activity remained generally Quiet to Unsettled (Kp 0-3)

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at Background levels. The high energy electron flux (greater than 2MeV), was initially High peaking 10000 pfu at 24/1545UTC, before falling to background after 25/0000 UTC. Electron fluence persisted above the 1e8 Active threshold throughout, with fluence at 25/0000UTC measured at 2.99e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low to Very Low, with four sunspot containing active regions on the visible disc, and further region or regions likely to rotate onto it. There is a slight (5%) chance of M-flares.

Solar Wind / Geomagnetic Activity: Current enhancement from the arrival of the fast wind of CH46 is expected to continue day 1 (25th) and into day 2 (26th), before very gradually easing, although there is the potential for a weak glancing impact during this period from a CME from a filament eruption on 22/0630UTC. The next notable enhancement will be from the arrival of the fast wind of CH47, most likely day 4 (28th) with the potential for another weak CME to glance

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across Earth towards midnight. This is currently considered more likely to miss, however, with only a slight chance of impact. Quiet to Active conditions at first day 1 (25th) and early day 2 (26th), will include the chance of isolated G1/Minor Storm intervals. Activity is then expected to be Quiet with Unsettled intervals, before increasing again to Unsettled to Active with a chance of G1/Minor Storm intervals with any fast wind arrival or CME influence on day 4 (28th).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at Background levels. The high energy electron flux (greater than 2MeV) is currently at background levels, and likely to persist at background to moderate, perhaps peaking briefly high once the current coronal hole source solar wind enhancement eases. There is a slight chance of more persistent high flux redeveloping. The associated 24hr electron fluence is expected to ease below the Active (1e8 integrated pfu) threshold during the next 12 hours, with any further Active fluence dependent upon more persistent flux returning day 2 onward (26th).

Figure 1. Observed Solar Winds, showing likely weak CME arrival, followed by CIR of CH46

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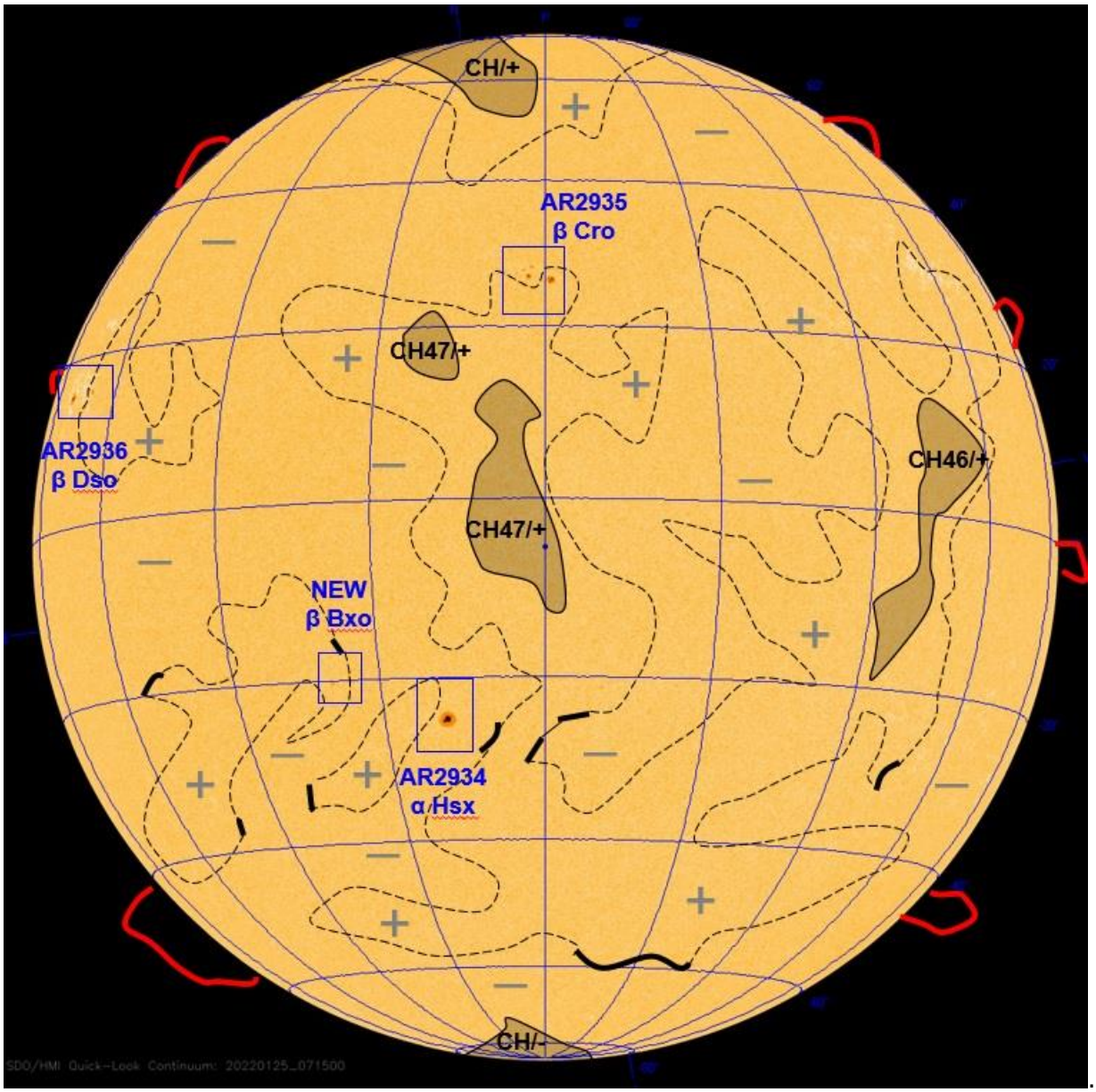
Figure 2. Solar Analysis Valid 25/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two CMEs that have the potential for glancing influence at Earth, however these are both low confidence. The first is from a filament eruption on 22/0630 UTC, which is estimated to arrive at 1 AU at 26/0000 UTC +/- 12 hours, but with notable uncertainty on how visible any arrival signal will be at L1. A further CME was observed, potentially from the B8-flare of AR2935 and associated filament eruption at around 25/0220 UTC. Whilst centrally located on the disc, this is expected to miss passing to the north of the Earth around 29/0000UTC+/- 9 hours, but again with a chance of glancing impact. Neither of these winds are expected to have a noticeable impact on solar wind speed.

Solar winds are currently being enhanced by the transition into the fast wind of CH46. Earth appears to have moved through a weak CIR region and into the main fast wind, with solar winds expected to peak around 500km/s later day 1 (25th). These winds are expected to ease a little day 2 and day 3 (26th and 27th), before a likely arrival of the fast wind of CH47 on day 4 (28th), with similar strength solar winds likely to CH46.

Quiet to Active conditions at first day 1 (25th) and early day 2 (26th), will include the chance of isolated G1/Minor Storm intervals mainly with any addition influence of the passing CME. Activity is then expected to be Quiet with Unsettled intervals, before increasing again to Unsettled to Active with a chance of G1/Minor Storm intervals with any fast wind arrival or CME influence on day 4 (28th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	10	1	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/0630	Partial	Filament	N15 E020	400	26/0001UTC	Possible glance
25/0220	Partial	Filament	N23 E001	376	29/0000 UTC	Likely missing but low chance glance.

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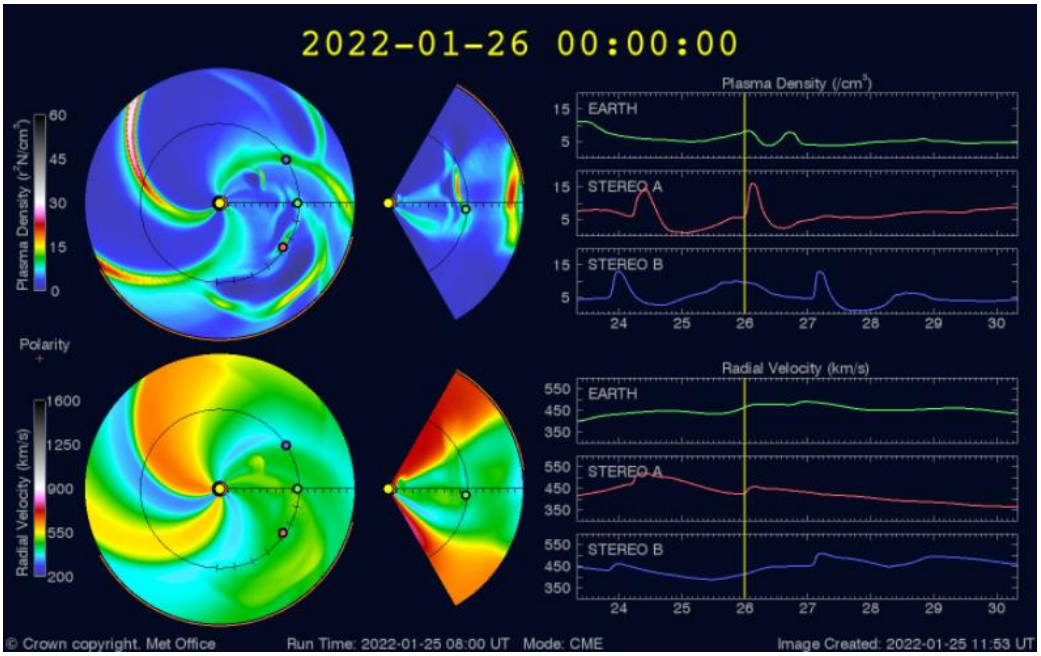
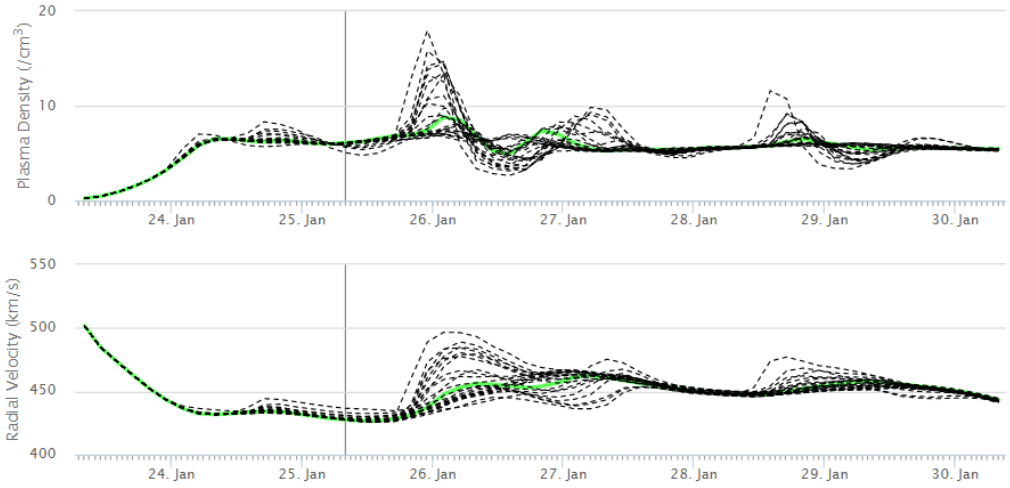
Figure 2: Enlil showing potential weak arrival 26/0000UTC with ensemble





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Radio Blackouts - X-Ray Flares:

Solar Activity is currently Low, with four active regions on the Earth-facing disc. The highest intensity flare, a C3.7 at 25/1029 UTC was from a region just over the northeast limb however, and hence currently not visible. This is identifiable as a bright region on STEREO A euvi imagery, however.

Of the Earth-facing regions, AR2935 Cro/Beta in the north-centre disc was a likely source of a B8 flare at 25/0220 but appears to have stabalised since this flare, with no further notable growth. AR2936 Dso/beta has remained relatively inactive near the northeast limb but, alongside its surrounding plage area, is potentially the region with the most notable magnetic flux energy available. The final numbered region AR2934 is a mature Hsx/alpha spot that has been traversing across the southern hemisphere as an inactive region. The fourth region is a new unnumbered spot to the northeast of AR2934, and whilst currently only a small Cro/Beta has fairly rapidly developed.

Alongside the flaring region mentioned above, another bright flux area is visible in the southeast on STEREO A euvi imagery, likely just over the limb. These regions, alongside the potential development of the above sunspots give a very slight (5%) chance of low M-flares (R1 Radio Blackout), but otherwise Very Low to Low activity is expected with C-flares possible.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES-16/17 X-ray Flux

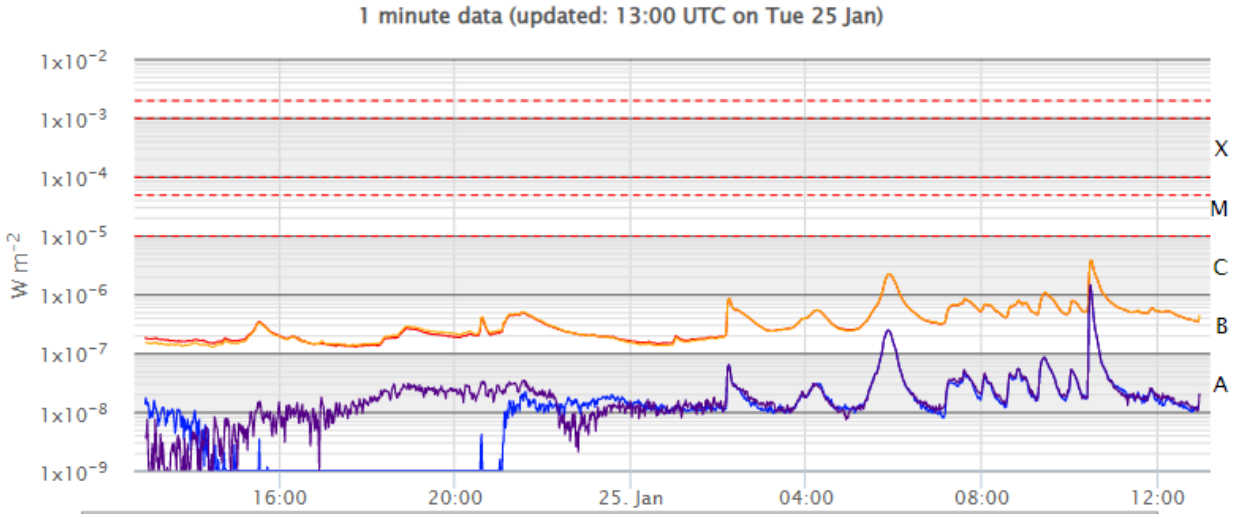

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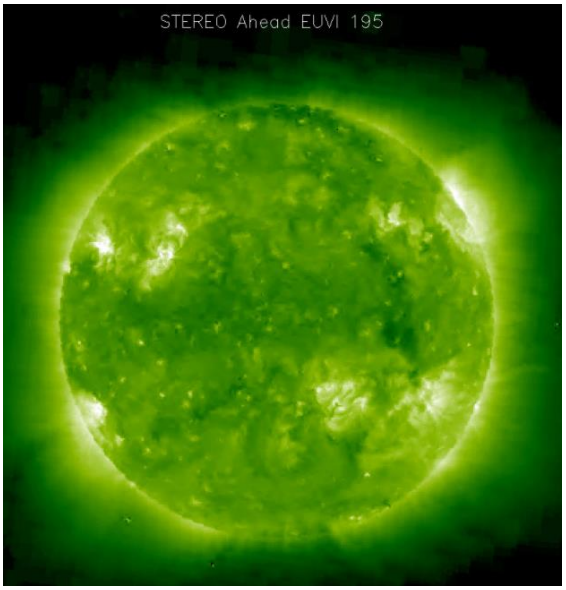
Figure 3: STEREO A euvi imagery showing a couple of potential active regions on E limb, which are due to rotate onto the visible side. North one was the source of the C3-flare.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. No solar radiation storms are expected in the period, with only a few simple and inactive sunspots on the Earth-facing side of the Sun.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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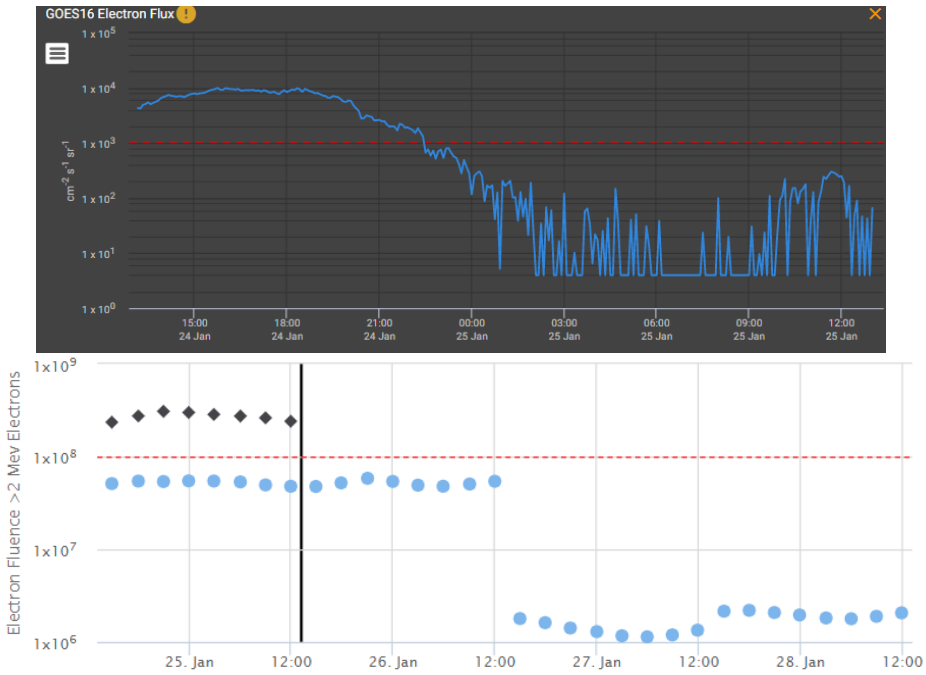
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO is currently background to Moderate, having dropped out overnight due to the arrival of a glancing CME on the 24th, followed by the transition into a CIR ahead of CH46 fast wind. The potential for a further glancing CME arrival later on day 1 will also prolong the dropout of values at GEO, should this occur. Whilst electron flux levels are expected to recover a little as any initial geomagnetic enhancement subsides, this is most likely to reach Moderate levels, with peak High flux, with only a chance of returning to more persistent High levels. Flux levels are likely to drop again day 4 (28th) due to the arrival of another fast wind from CH47, and the chance for another CME glance.

The associated 24 hour fluence, whilst currently well over the Active threshold is likely to fall below this level during the next 12 hours, with only a chance of persisting above. A chance of further Active fluence is then maintained through the period, either from a further gradual build of levels as the forthcoming fast wind enhancement to the solar wind eases, or from the low chance of high flux levels being maintained. REFM is currently giving poor guidance, as this is not taking account of the current fast wind enhancement that is occurring, or any subsequent CME arrivals.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	30	30	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: GOES-16 >2MeV Electron Flux with associated Fluence and REFM.



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